



Helicopter Dynamic Components Project

*Presented at:
HCAT Meeting
January 2006*

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Technical Objectives

- *Conduct demonstration/validation program that will result in qualification of HVOF- thermal spray coatings as replacements for hard chrome plating for manufacturing and repair of helicopter dynamic components on military aircraft, including rotor head, transmission and gearbox components;*
- *Through materials testing and component evaluations, demonstrate improved performance and reduced life-cycle costs for HVOF coatings as compared to hard chrome*

Project Plan

- *Demonstration site: Naval Air Depot Cherry Point*
 - *HCAT acquired and installed HVOF system in Cherry Point in 1998*
- *Contracts awarded to Sikorsky (H60); Boeing (H46/H47) and Bell (UH-1/AH-1) in 2003*
 - *Conducted analysis of helicopter dynamic components onto which hard chrome is applied by OEM or in repair*
 - *Identified materials and rig tests that would be required to qualify HVOF coatings as replacement for chrome on their components*
 - *Submitted reports on results of analysis and designation of required tests*
 - *Participated in stakeholders meeting to complete Joint Test Protocol and discuss potential component rig tests*

Project Activities

- *Component tests for qualification of HVOF*
 - *Flight test on H-46 generator gears*
 - *Rig test to be performed on UH-1 transmission rotor brake disc adapter*
 - *Rig test to be performed on UH-1 tail rotor control rod*
 - *NADEP Cherry Point discussing possible rig testing at Pax River on sun gear and pinion gear from H-46*
- *Execution of Cost/Benefit ECAM analysis by CTC at NADEP Cherry Point for implementation of HVOF*
- *Development of standards and specifications for depositing HVOF coatings on dynamic components*

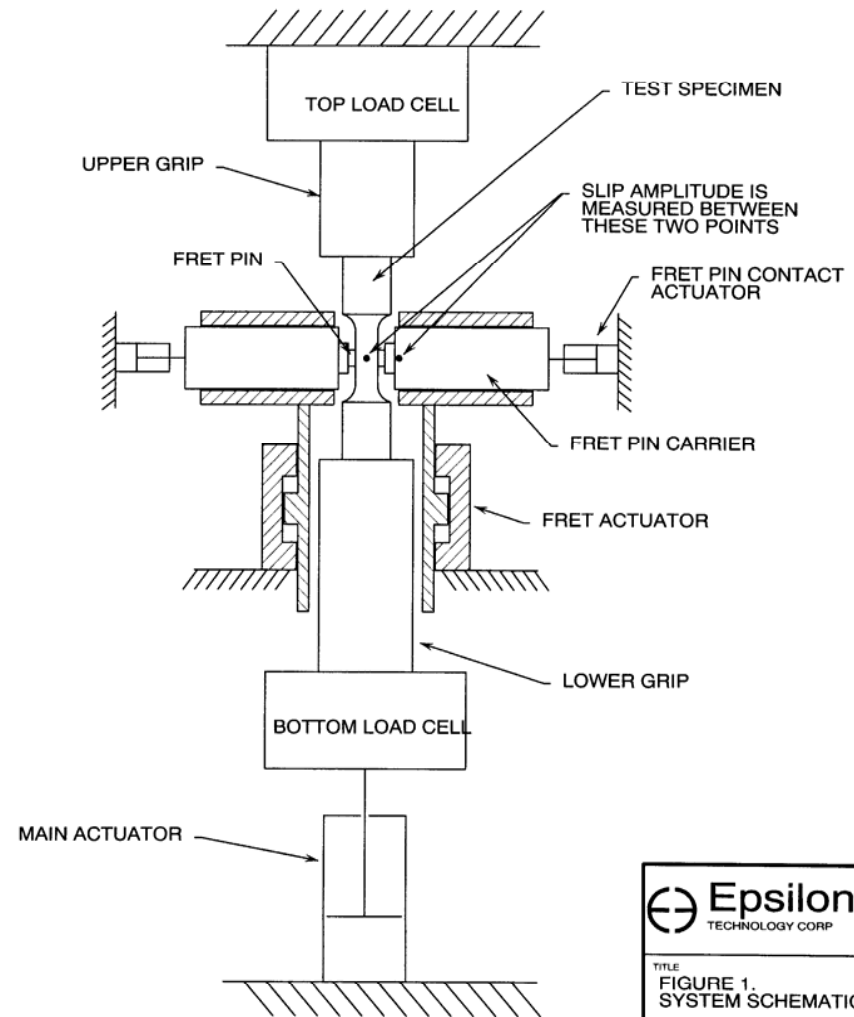
Materials Joint Test Protocol


- *At stakeholders meeting and through subsequent discussions, developed Materials Joint Test Protocol*
- *Base materials to be evaluated:*
 - *4340 steel (200-220 ksi)*
 - *PH13-8Mo stainless steel*
 - *9310 carburized steel*
 - *Aluminum 7075-T73 alloy*
- *Coatings to be evaluated:*
 - *WC/17Co and WC/10Co4Cr*
 - *Tribaloy 400*
 - *WC/17Co plus T-400 bond layer for Al alloy only*
- *Materials testing to be performed includes axial fatigue, G85 SO₂ salt fog corrosion and crevice corrosion, F519 environmental embrittlement, and fluid compatibility testing*

Fretting Fatigue Test

- *Working with Sikorsky, identified fretting fatigue test developed at United Technologies as critical for qualification of HVOF coatings on dynamic components; this type of test has not been performed in any of the other HVOF projects*
- *Coated fretting fatigue specimen is tested in axial loading while the fret pins bear against the center of the gage surface with a constant load and slip against the fretting specimen surface at an amplitude controlled by the fret actuator*

Figure 1. Schematic of Fret System

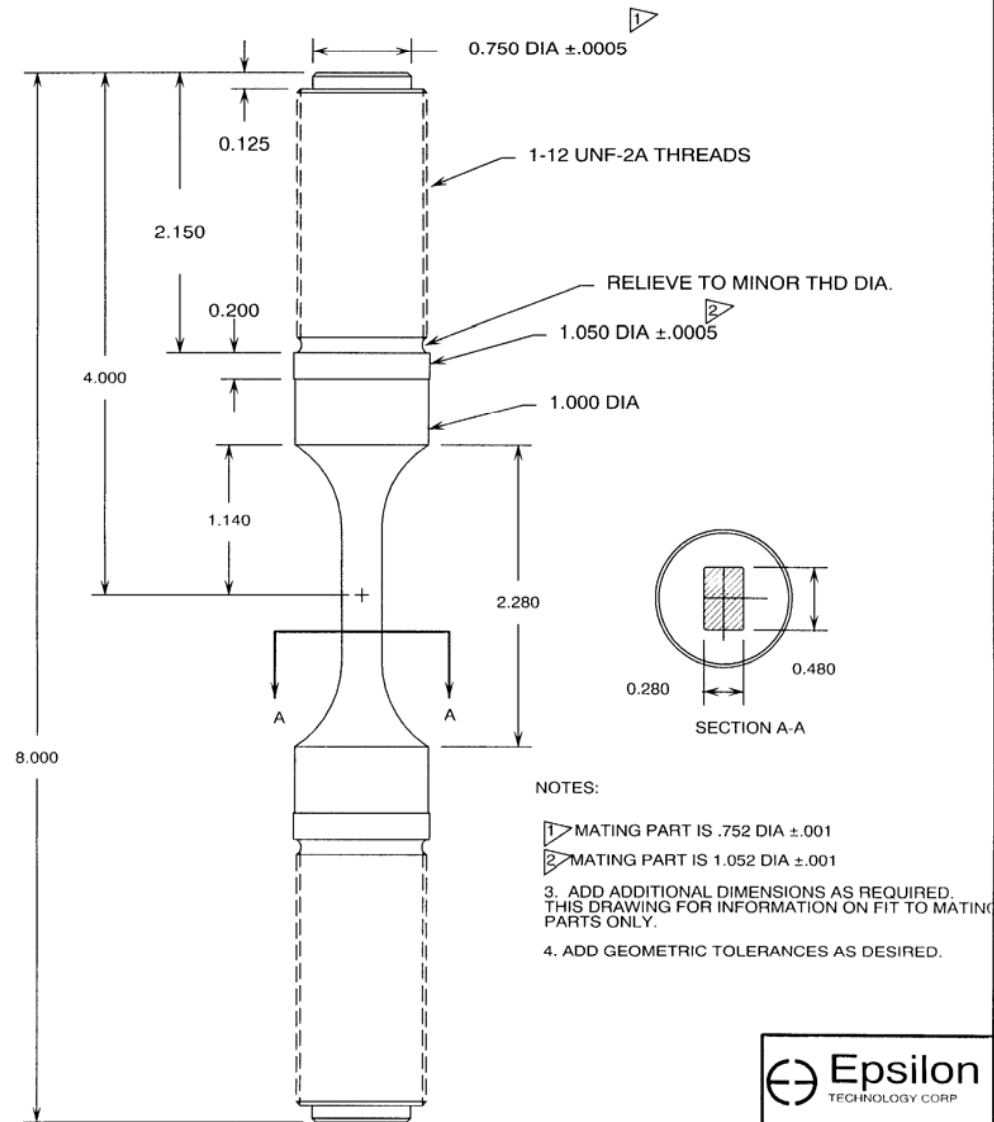


 Epsilon TECHNOLOGY CORP.		
TITLE FIGURE 1. SYSTEM SCHEMATIC		
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SHEET 1 OF 1		

Fretting Fatigue Test

- Fretting fatigue specimen fabricated from round bar with rectangular cross section; shot peened and grit blasted prior to coating
- Hard chrome or HVOF coatings applied along entire gage length
- Hard chrome coatings to be ground to specified surface finish; HVOF to be ground or superfinished

Figure 9. Test Specimen for Fret Tests



10/23/95

FULL SCALE

SHEET 1 OF 1

Fretting Fatigue Test

Fretting fatigue test matrix established as follows:

Fretting fatigue test matrix.

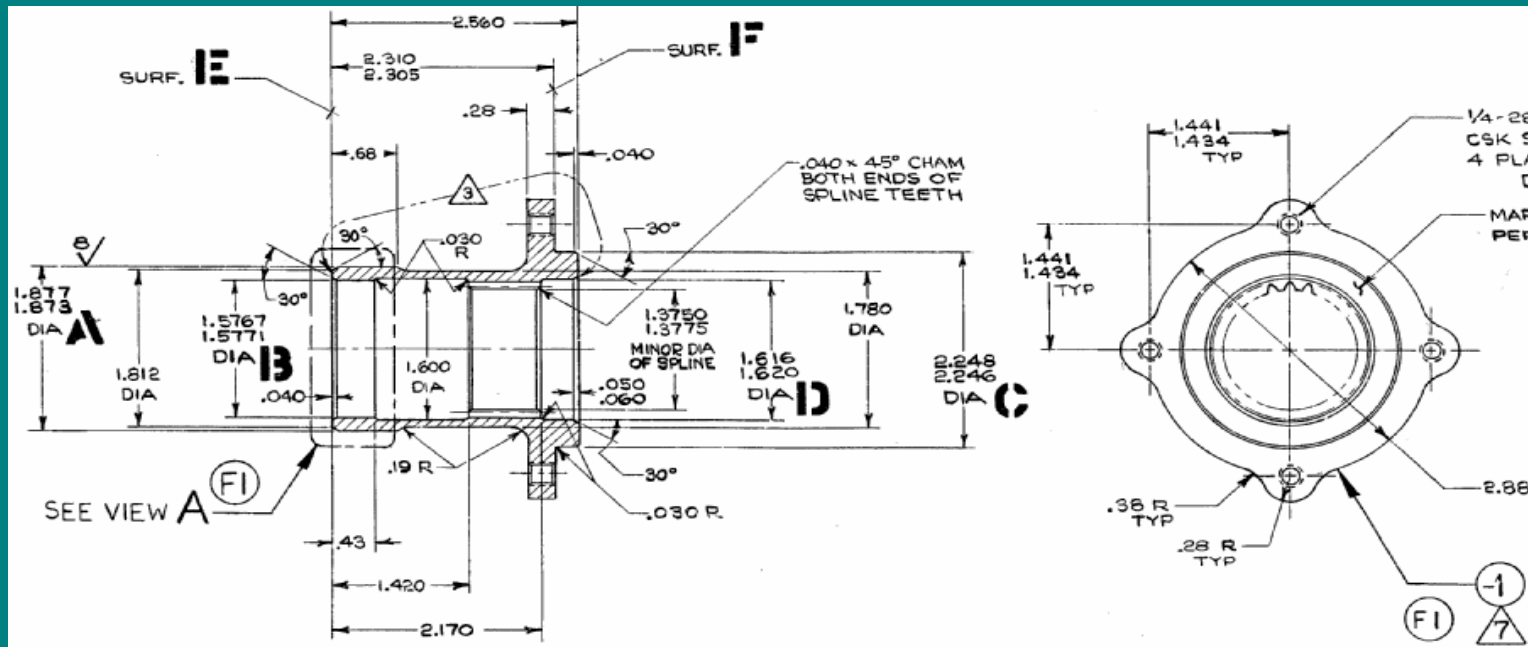
Coating	Thick- ness (mil)	Surface finish (μ'')	# of specimens PH13-8Mo	# of specimens 9310 carb	# of specimens 7075 Al	# of specimens 4340
EHC	10-12	4-6 ground	3	3	3	3
WC-Co	10-12	4-6 ground	3	3	3	3
WC-CoCr	10-12	4-6 ground	3	3	3	3
T400	10-12	4-6 ground	3	3	3	3
T-400 + WC-Co	7-9/3-4	4-6 ground			3*	
EHC	10-12	1-2 super	3	3	3	3
WC-Co	10-12	1-2 super	3	3	3	3
WC-CoCr	10-12	1-2 super	3	3	3	3
T400	10-12	1-2 super	3	3	3	3
T-400 + WC-Co	7-9/3-4	1-2 super			3*	
Total			24	24	30	24
Grand total						102

Component Testing

- *Contract issued for Bell Helicopter to perform UH-1 tail rotor control rod component test*
 - *Test setup to duplicate current aircraft installation, i.e., seal and guide bearing identical as on UH-1*
 - *Test to be conducted for 50,000 cycles at full stroke (10 full pedal strokes per hour for 5000 flight hours), followed by component inspection*
 - *Then test parts to be reassembled and run additional 5000 cycles with a light coat of gearbox lubricant and Arizona road dust applied to test surfaces; component inspected at end of test*
 - *Two tests to be performed: one with standard hard chrome plate on component and one with HVOF WC/Co on component; performance comparison will be made*

Component Testing

- Contract issued to Bell Helicopter to perform 100-hour bench test on UH-1 transmission rotor brake disc adapter flange
- HVOF WC/Co-coated flange will be installed in a transmission during testing so that mating seal will be run in the same lubrication environment as during normal operation



Component Testing

- *Two H-46 generator gears coated with WC/Co for 900-hour lead-the-fleet flight test*
- *Flight clearance was obtained from NAVAIR*
- *Gears have been in production shop at Cherry Point awaiting installation for over two years*
- *Once installed, gears will be inspected every 100 flight hours*



Technology Transfer

- *Dynamic component change approved for damper assembly on CH-53 (NAVAIR executing change in cooperation with Sikorsky)*
- *HVOF WC/Co to be applied to piston and lands on cylinder housing*
- *Miniature plasma spray gun to be used to apply Triballoy 400 to ID of cylinder and positioner housing (approximately 3-inch ID)*
- *Drawings have been changed to reflect application of new HVOF coatings; repair work to be performed in-house at Cherry Point using production HVOF systems*
- *Cherry Point discussing acquisition of miniature plasma spray gun with vendors*